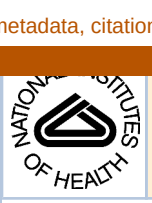

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Second-stage labor duration in nulliparous women: relationship to maternal and perinatal outcomes

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Abstract

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Condensation: Increasing duration of the second stage of labor in nulliparas is associated principally with adverse *maternal* outcomes. The second stage does not need to be terminated for duration alone.

Objective—To assess maternal and perinatal outcomes as a function of second stage labor duration.

Methods—We assessed outcomes in nulliparous laboring women enrolled in a trial of fetal pulse oximetry.

Results—Of 5,341 participants, 4,126 reached the second stage. As duration of the second stage increased, spontaneous vaginal delivery rates declined, from 85% when the duration was under one hour to 9% when it was 5 hours or more. Adverse maternal outcomes significantly associated with the duration of the second stage included chorioamnionitis (overall rate 3.9%), 3rd or 4th degree perineal laceration (8.7%), and uterine atony (3.9%). Odds ratios (ORs) for each additional hour of the second stage ranged from 1.3 to 1.8. Among individual adverse neonatal outcomes, only admission to a neonatal intensive care unit was significantly associated with second stage duration (OR 1.4).

Conclusions—The second stage does not need to be terminated for duration alone.

Introduction

Recent studies suggest that while the duration of the second stage of labor is associated with increased risks of certain adverse maternal outcomes, there is no relationship between the duration of the second stage and adverse neonatal outcomes. However, most studies of this issue are from single centers,[1-7] and all are based on retrospectively collected data. We therefore took advantage of data collected during a randomized clinical trial to assess whether there is a relationship between the duration of the second stage of labor in nulliparous women and adverse maternal or neonatal outcomes using prospectively collected, multi-center data.

Material and Methods

This is a secondary analysis of a clinical trial of fetal pulse oximetry conducted at the 14 clinical centers of the National Institute of Child Health and Human Development Maternal Fetal Medicine Units Network. Participants were nulliparas carrying a singleton vertex fetus who labored spontaneously or were induced at or beyond 36 weeks' gestation.[8] The present analysis was confined to participants who reached the second stage of labor. Exclusion criteria for the trial included maternal fever immediately prior to randomization, and serious medical conditions such as diabetes mellitus. Pregnancy-associated hypertension was not an exclusion criterion. Each participating center had Institutional Review Board approval for the study.

Maternal and neonatal data were collected by trained research nurses, who were present during the labor to manage the fetal oximeter. Duration of the second stage was calculated as the number of minutes from the first cervical examination revealing full dilatation until delivery. Maternal morbidities are limited to diagnoses made after the start of the second stage, including chorioamnionitis, which for study purposes required that the clinical diagnosis had been made, the intrapartum temperature reached at least 38° C, and at least one of the following was present: uterine tenderness, foul smelling vaginal discharge or amniotic fluid, or maternal or fetal tachycardia. The study diagnosis of endometritis required a clinical diagnosis and a post-partum temperature of at least 38° C. Other maternal morbidities were defined on the basis of clinical diagnoses. Perineal laceration data were collected only for women who delivered vaginally.

Brachial plexus injury was confirmed by central review of records, and was diagnosed only when the injury was present at neonatal discharge. Other neonatal morbidities were defined on the basis of clinical diagnoses. In the original trial, a composite outcome of serious neonatal morbidity was defined *a priori*, and consisted of any of the following: a 5-minute Apgar score below 4, an umbilical artery pH value under 7.0, seizures, intubation in the delivery room,

stillbirth, neonatal death, or admission to a neonatal intensive care unit (NICU) for more than 48 hours.

The second stage of labor was analyzed both as a continuous and as a dichotomous variable: less than three hours versus three hours or greater. The division at three hours was based on the conventional threshold for defining a prolonged second stage of labor in a nullipara receiving epidural analgesia.[9] Associations between duration of the second stage and the various maternal and neonatal outcomes were analyzed using logistic regression for the continuous duration and chi-square or Fisher's exact tests for the dichotomous measure. Logistic regression models for both the continuous and dichotomous measures were used to adjust for mode of delivery (spontaneous, operative vaginal, and cesarean). Additional models adjusting for maternal body mass index at delivery and duration of the first stage of labor were analyzed when the outcomes were frequent enough to support valid logistic regressions.

Due to the infrequency of brachial plexus injury, sepsis, and low 5-minute Apgar score, exact logistic regression was used for these outcomes. All reported P values are two-sided and a $P < 0.05$ was considered significant. No adjustments were made for multiple comparisons. SAS software (SAS Institute, Inc, Cary, NC) and LogXact (Cytel Software Corp., Cambridge, MA) software were used for analysis.

Results

Of 5,341 parturients enrolled in the clinical trial from May 2002 to February 2005, 4,126 (77%) reached the second stage of labor and these 4,126 women and their neonates constitute the study cohort (Table 1). There was no observed effect of the original clinical trial exposure groups (fetal pulse oximetry or not) on either the duration of the second stage or the maternal and neonatal outcomes of interest (data not shown). Therefore, all patients were analyzed independent of fetal pulse oximetry use. As duration of the second stage increased, spontaneous vaginal delivery rates declined, from 85.2% of those delivering with less than one hour in the second stage down to 8.7% of those who remained in the second stage for 5 or more hours (Table 2).

In unadjusted analyses, several adverse maternal outcomes were significantly associated with the duration of the second stage, including chorioamnionitis, endometritis, 3rd or 4th degree perineal laceration, uterine atony, and blood transfusion (Table 2). After adjustment for mode of delivery, the association with endometritis and blood transfusion was no longer significant (Table 2). There were no stillbirths or neonatal deaths, and one case of neonatal hypoxic ischemic encephalopathy (in this case the duration of the second stage was 2 hrs, 11 minutes).

Without adjustment for mode of delivery, admission to a neonatal intensive care unit and the composite of serious morbidities were the only two neonatal morbidities significantly associated with 2nd stage duration (Table 2). Admission to a neonatal intensive care unit for at least 48 hours is alone responsible for 62% (n = 64) of the neonatal composite; when limited to the remaining components, the composite of morbidities is no longer associated with 2nd stage duration. After adjustment for mode of delivery, only brachial plexus injury present at discharge was associated with second stage duration (Table 2). The individual cases of brachial plexus injury are described in Table 3.

The second stage of labor lasted at least three hours in 360 women, or 9 percent of the cohort. In these women, rates of spontaneous vaginal delivery were significantly lower, and rates of operative vaginal and cesarean delivery higher than in women in whom the second stage lasted under three hours. Even so, the majority (55%) of the 360 women with a second stage of at least three hours delivered vaginally. Sixty-one percent (n = 89) of cesareans with a second

stage under three hours were performed for dystocia, versus 93% (n = 149) when the second stage was longer.

In unadjusted analyses, second stage duration of at least three hours was associated with significantly higher rates of chorioamnionitis, endometritis, 3rd or 4th degree perineal lacerations, uterine atony, and blood transfusion (Table 4). After adjustment for mode of delivery, the association with endometritis and blood transfusion was no longer significant (Table 4). Without adjustment for mode of delivery, admission to a neonatal intensive care unit and the composite of serious morbidities were the only two neonatal morbidities significantly associated with a second stage duration of at least 3 hours (Table 4). However, after adjustment for mode of delivery, neonatal outcomes did not differ significantly between the patients with second stage < 3 versus ≥ 3 hours. Outcomes stratified by mode of delivery and duration of second stage (< 3 hours or ≥ 3 hours) are presented in Table 5. Additional regression analyses were performed that included body mass index at delivery and duration of the first stage of labor; however, the results were essentially identical (data not shown).

Discussion

These data, prospectively collected from 14 centers, reaffirm that with current labor management practices, the duration of the second stage of labor is associated principally with adverse maternal as opposed to adverse neonatal outcomes. Without adjustment for mode of delivery, of the several individual adverse neonatal outcomes that we examined, only one, admission to a neonatal intensive care unit, correlated with second stage duration, and it, per se, is not strictly a true morbidity. Likewise, the composite outcome of serious neonatal morbidity was significantly associated with second stage duration, but the neonatal intensive care unit admission component comprised 62% of this composite outcome. After controlling for mode of delivery, only one adverse neonatal outcome, brachial plexus injury present at discharge, correlated with second stage duration, and the absolute risk of this outcome (3/1,000) was low.

Cohen, in a study of 4,403 nulliparas, was the first to observe that while certain maternal morbidities, specifically post-partum hemorrhage and fever, were increased when the second stage of labor was prolonged, neither 5-minute Apgar scores nor perinatal mortality were related to second stage duration.[1] Saunders et al. came to a similar conclusion in their retrospective review of a regional obstetric database.[10] Among 25,069 term deliveries, maternal infection and post-partum hemorrhage were related to the duration of the second stage, but neonatal condition, as reflected by low Apgar scores or admission to a special care nursery, was not. Presumably because relatively few women in their cohort had second stage durations that exceeded three hours, they limited their conclusions to durations that did not exceed this threshold.

Menticoglou and his colleagues extended the work of Cohen and Saunders et al when they reported that among 6,041 nulliparas, the second stage exceeded three hours in 11% and five hours in 3%.[3] They found no relationship in their cohort between second-stage duration and low 5-minute Apgar score, neonatal seizures, or NICU admission. Moreover, one in four women who was still undelivered after four hours in the second stage achieved vaginal delivery in the next hour.

Janni et al reported that the duration of the second stage exceeded four hours in 4% of 1,457 women, and that second stage duration bore no relationship to neonatal outcome.[4] His group did observe that the rate of third degree perineal lacerations increased as the second stage lengthened. For example, when the second stage was under two hours, the rate of such tears was 3%, whereas it was 11% when the second stage lasted from 3-4 hours. More recently,

Myles and Santolaya and Cheng et al have reported similar maternal and neonatal outcomes in relationship to second stage duration.[6,7] Our study is thus consistent with previous findings.

The strengths of our data are that they were prospectively accrued, reflect practice patterns and outcomes from 14 centers, and were collected by research nurses present during the second stage of labor and delivery. Weaknesses of our data include the fact that second stage labor management was not standardized, which limits somewhat the value of the causal implications of the data. That is, the complications that we observed in association with second stage duration may not per se be due to duration, or at least duration alone. Similarly, for several of the complications, our study design does not allow us to say that the complications would have been avoided if the second stage had been terminated sooner. Another potential weakness is that even with a sample size of over 4,000, our statistical power to detect an increased risk of several complications in association with the duration of the second stage was low. Finally, since 95% of women in the study cohort received epidural analgesia, our findings shouldn't be generalized to women who labor without such analgesia.

Although we did not collect information on shoulder dystocia, we did collect information on the often associated and more meaningful outcome of brachial plexus injury. By logistic regression analysis, each additional hour in the second stage significantly increased the risk of this outcome by approximately 80%. We caution, however, that this risk estimate is modeled, and based on only 11 cases, and thus the 95% confidence interval is wide and consistent with a risk increase of as little as 10% or as great as 280%. Moreover, in only two of the eleven cases did the duration of the second stage equal or exceed three hours, and in only four was birth weight at least 4000 gm. Finally, we did not follow-up the neonates beyond discharge, which is important, since as many as 90% of brachial plexus injuries resolve spontaneously without sequelae.[11] Thus the clinical implications of this association are unclear.

In infants who are delivered vaginally, the risk of brachial plexus injury is increased at higher birth weights.[11] However, for two reasons, one statistical and one conceptual, we did not adjust for birth weight in our regression models. First, the infrequency of brachial plexus injury rendered such adjustment statistically unreliable. Second, birth weight can only be *estimated* prior to delivery, and incorporation of such estimates into clinical management strategies is generally unrewarding,[11] especially if, as in this study, the majority of brachial plexus injuries occurred in babies with birth weights below 4000 gm.

Our data should aid in counseling and in the management of the second stage of labor. They support that extending the duration of the second stage of labor will allow some women to successfully achieve vaginal delivery, even those few women in whom the second stage has lasted five hours. These vaginal deliveries, however, have a cost, including higher rates of significant perineal trauma, infectious morbidity, and uterine atony. Some women and their caregivers will find these tradeoffs in attempting to avoid cesarean delivery acceptable, and some will not. The only associated downsides for the fetus to a longer second stage are a higher, but still low rate of admission to a neonatal intensive care unit, and, when adjustment is made for mode of delivery, an increased relative, but still low absolute risk of brachial plexus injury Again, how these risks are perceived and acted upon is likely to vary substantially.

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Table 1

Maternal and Neonatal Characteristics and Outcomes

Maternal Characteristics	
Age (y)	23.3 ± 5.4
Race	
Black	1,217 (29.5)
White	2,196 (53.2)
Asian	58 (1.4)
Other	655 (15.9)
Body mass index (kg/m^2)	
Pre-pregnancy	25.0 ± 5.8
Delivery	31.0 ± 6.0
Ethnic group	
Hispanic or Latino	1,010 (24.5)
Not Hispanic or Latino	3,116 (75.5)
Gestational age (wk)	39.7 ± 1.3
Type of labor	
Spontaneous	2,535 (61.4)
Induced	1,591 (38.6)
Use of oxytocin	3,592 (87.1)
Use of epidural analgesia	3,916 (94.9)
Duration of 1st stage of labor	13.6 ± 7.1
Type of delivery	
Spontaneous	3,054 (74.0)
Operative vaginal	765 (18.5)
Cesarean	307 (7.4)
Chorioamnionitis*	151 (3.9)
3rd or 4th degree perineal laceration**	332 (8.7)
Endometritis	121 (2.9)
Uterine atony	160 (3.9)
Blood transfusion	36 (0.9)
Neonatal Characteristics and Outcomes	
Birthweight (gm)	3335 ± 451
5-minute Apgar < 4	3 (0.1)
Umbilical artery pH < 7.0***	16 (0.5)
Intubation in delivery room	20 (0.5)
Neonatal intensive care admission	181 (4.4)
Sepsis	6 (0.1)
Brachial plexus injury	11 (0.3)
Composite#	104 (2.5)

Data are presented as mean (± standard deviation) or number (percent)

* Excludes 246 women diagnosed with chorioamnionitis in the first stage.

** Vaginal deliveries only

*** Values available for 3,524 fetuses.

Any of the following: a 5-minute Apgar score below 4, an umbilical artery pH under 7.0, seizures, intubation in the delivery room, stillbirth, neonatal death, or admission to a neonatal intensive care unit for more than 48 hours

Table 2

Delivery mode and adverse outcomes by duration of the second stage

	< 1 hr; (n= 1901)	1-< 2 hr (n= 1251)	2- <3 hr (n= 614)	3- < 4 hr (n= 217)	4-< 5 hrs (n= 97)	≥5 hrs (n= 46)	Unadjusted OR (95% CI) or P	Adjusted OR (95% CI) ^
Delivery Mode								
Spontaneous	1620 (85.2)	984 (78.7)	363 (59.1)	59 (27.2)	24 (24.7)	4 (8.7)	<0.01	--
Operative Vaginal	254 (13.4)	226 (18.1)	173 (28.2)	75 (34.6)	27 (27.8)	10 (21.7)		
Cesarean	27 (1.4)	41 (3.3)	78 (12.7)	83 (38.3)	46 (47.4)	32 (69.6)		
Maternal outcomes								
Chorioamnionitis	20 (1.1)	49 (4.2)	41 (7.1)	29 (14.8)	9 (10.6)	3 (6.5)	1.68 (1.51, 1.87)	1.60 (1.40, 1.83)
3rd or 4th degree perineal laceration	96 (5.1)	101 (8.4)	74 (13.8)	45 (33.6)	12 (23.5)	4 (28.6)	1.80 (1.62, 1.99)	1.44 (1.29, 1.60)
Endometritis	51 (2.7)	33 (2.6)	15 (2.4)	13 (6.0)	2 (2.1)	7 (15.2)	1.25 (1.09, 1.43)	1.07 (0.90, 1.26)
Uterine atony	57 (3.0)	45 (3.6)	30 (4.9)	17 (7.8)	7 (7.2)	4 (8.7)	1.29 (1.15, 1.45)	1.31 (1.14, 1.51)
Blood transfusion	11 (0.6)	12 (1.0)	6 (1.0)	4 (1.8)	1 (1.0)	2 (4.3)	1.38 (1.11, 1.72)	1.30 (0.99, 1.71)
Neonatal Outcomes								
5-minute Apgar < 4	0 (0.0)	2 (0.2)	1 (0.2)	0 (0.0)	0 (0.0)	0 (0.0)	1.34 (0.62, 2.88)	1.05 (0.34, 2.46)
Umbilical artery pH < 7.0	4 (0.2)	6 (0.6)	4 (0.8)	1 (0.5)	1 (1.2)	0 (0.0)	1.30 (0.91, 1.87)	0.98 (0.63, 1.53)
Intubation in delivery room	7 (0.4)	7 (0.6)	5 (0.8)	0 (0.0)	1 (1.0)	0 (0.0)	1.14 (0.80, 1.62)	0.99 (0.65, 1.51)
Neonatal intensive care	61 (3.2)	62 (5.0)	29 (4.7)	15 (6.9)	9 (9.3)	5 (10.9)	1.27 (1.14, 1.42)	1.13 (0.98, 1.29)
Sepsis	2 (0.1)	3 (0.2)	1 (0.2)	0 (0.0)	0 (0.0)	0 (0.0)	1.04 (0.52, 2.10)	0.88 (0.38, 2.03)
Brachial plexus injury	3 (0.2)	2 (0.2)	4 (0.7)	1 (0.5)	1 (1.0)	0 (0.0)	1.41 (0.96, 2.06)	1.78 (1.08, 2.78)
Composite#	33 (1.7)	36 (2.9)	19 (3.1)	10 (4.6)	4 (4.1)	2 (4.4)	1.25 (1.08, 1.45)	1.09 (0.91, 1.30)

Data are presented as number (percent)

^ Odds ratio (95% confidence interval) for each additional hour of the second stage adjusted for mode of delivery

Any of the following: a 5-minute Apgar score below 4, an umbilical artery pH under 7.0, seizures, intubation in the delivery room, stillbirth, neonatal death, or admission to a neonatal intensive care unit for more than 48 hours

Table 3

Selected characteristics of pregnancies complicated by brachial plexus injury

Duration of the Second Stage (hrs)	Birth weight (gm)	Method of Delivery	Station* at Forceps
0.2	3000	Forceps	+2
0.4	3220	Spontaneous	
0.8	2155	Forceps	+2
1.3	3535	Spontaneous	
1.4	4790	Spontaneous	
2.1	4110	Spontaneous	
2.2	3800	Spontaneous	
2.2	4307	Spontaneous	
2.6	3280	Spontaneous	
3.8	3135	Forceps	+2
4.9	4460	Spontaneous	

* On a scale of 0-5 cm

Table 4

Second stage duration and outcomes categorized by duration < or ≥ 3 hours

	< 3 Hours (n = 3766)	≥ 3 Hours (N = 360)	P (unadjusted)	P (adjusted ^)
Delivery Mode				
Spontaneous	2967 (78.8)	87 (24.2)	<0.01	--
Operative Vaginal	653 (17.3)	112 (31.1)		
Cesarean	146 (3.9)	161 (44.7)		
Maternal outcomes				
Chorioamnionitis	110 (3.1)	41 (12.5)	<0.01	<0.01
3rd or 4th degree perineal laceration*	271 (7.5)	61 (30.7)	<0.01	<0.01
Endometritis	99 (2.6)	22 (6.1)	<0.01	0.20
Uterine atony	132 (3.5)	28 (7.8)	<0.01	<0.01
Blood transfusion	29 (0.8)	7 (1.9)	0.03	0.24
Neonatal Outcomes				
5-minute Apgar < 4	3 (0.1)	0 (0.0)	1.00	0.90
Umbilical artery pH < 7.0	14 (0.4)	2 (0.7)	0.64	0.50
Intubation in delivery room	19 (0.5)	1 (0.3)	1.00	0.23
Neonatal intensive care	152 (4.0)	29 (8.1)	<0.01	0.25
Sepsis	6 (0.2)	0 (0.0)	1.00	0.72
Brachial plexus injury	9 (0.2)	2 (0.6)	0.25	0.27
Composite#	88 (2.3)	16 (4.4)	0.01	0.69

Data are presented as number (percent), or mean +/- SD

^ Adjusted for mode of delivery

* Vaginal deliveries only

Any of the following: a 5-minute Apgar score below 4, an umbilical artery pH under 7.0, seizures, intubation in the delivery room, stillbirth, neonatal death, or admission to a neonatal intensive care unit for more than 48 hours

Table 5

Outcomes stratified by mode of delivery and second stage duration < or ≥ 3 hours

	Vaginal			Cesarean		
	< 3 Hours (n = 3620)	**≥ 3 Hours (n = 199)**	**P**	**< 3 Hours (n = 146)**	**≥3 Hours (n = 161)**	**P**
Maternal outcomes						
Chorioamnionitis	101 (3.0)	21 (11.4)	<0.01	9 (6.8)	20 (14.0)	0.05
3rd or 4th degree perineal laceration	271 (7.5)	61 (30.7)	<0.01			
Endometritis	87 (2.4)	9 (4.5)	0.06	12 (8.2)	13 (8.1)	0.96
Uterine atony	124 (3.4)	17 (8.5)	<0.01	8 (5.5)	11 (6.8)	0.62
Blood transfusion	26 (0.7)	4 (2.0)	0.07	3 (2.1)	3 (1.9)	1.00
Neonatal Outcomes						
5-minute Apgar < 4	2 (0.1)	0 (0.0)	1.00	1 (0.7)	0 (0.0)	0.48
Umbilical artery pH < 7.0	11 (0.4)	1 (0.6)	0.47	3 (2.3)	1 (0.8)	0.62
Intubation in delivery room	16 (0.4)	1 (0.5)	0.60	3 (2.1)	0 (0.0)	0.11
Neonatal intensive care	140 (3.9)	14 (7.0)	0.03	12 (8.2)	15 (9.3)	0.73
Sepsis	5 (0.1)	0 (0.0)	1.00	1 (0.7)	0 (0.0)	0.48
Brachial plexus injury	9 (0.2)	2 (1.0)	0.11	0 (0.0)	0 (0.0)	---
Composite*	79 (2.2)	8 (4.0)	0.13	9 (6.2)	8 (5.0)	0.65

*Any of the following: a 5-minute Apgar score below 4, an umbilical artery pH under 7.0, seizures, intubation in the delivery room, stillbirth, neonatal death, or admission to a neonatal intensive care unit for more than 48 hours